Decarbonising the Grid

Three scenarios for achieving Net Zero Power

Thomas Cabot

Modelling by Aurora Energy Research

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About the Author

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A Note on Sources

All modelling and energy data using within this report was provide through **Aurora Energy Research**, an independent energy research company. Aurora's 'Pathways and Challenges to Decarbonise the GB Power Sector' report and high-level scenario data book can be viewed as standalone documents on Policy Exchange's website. Of note, the figures presented in graphics of this report and Aurora's Net Zero report are rounded values. For exact figures please refer to Aurora's data book that accompanies their report, and provides an accurate breakdown of the modelled figures.

Any data points used to inform the report from open sources and independent of Aurora's data, have been referenced accordingly.

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Contents

1. Executive Summary

The UK is in he midst of a radical transformation of its power sector: from high carbon generation to low carbon generation. Since 2010, the UK's power sector overall emissions intensity has reduced by 69%,[1] with approximately 40% of the UK's power coming from renewables in 2021.[2] Nevertheless, the power sector remains a significant contributor to the UK's domestic carbon emissions, with power stations alone accounting for 16% of all CO_2 emissions in 2022, at 53.7 $MtCO_2$.[3]

Policy Exchange has commissioned Aurora Energy Research, to provide a rigorous analysis of different scenarios in which Great Britain[4] could achieve a Net Zero power sector. The report uses state-of-the-art economic modelling - conducted by Aurora Energy Research - to calculate the capital investment and carbon emissions saved under the power sector targets set by both Labour and the Conservatives. Three different pathways are modelled:

- **Net Zero 2030 (NZ 30):** a scenario aiming to deliver Net Zero in the power sector by 2030, in line with the target announced by Labour.
- **Net Zero 2035 (NZ 35):** a scenario aiming to deliver Net Zero in the power sector by 2035, in line with the target announced by the Conservative Government, and recommended by the independent Climate Change Committee.
- **'Business-As-Usual':** a scenario following the current trajectory of policy development and market environment for the GB power sector.

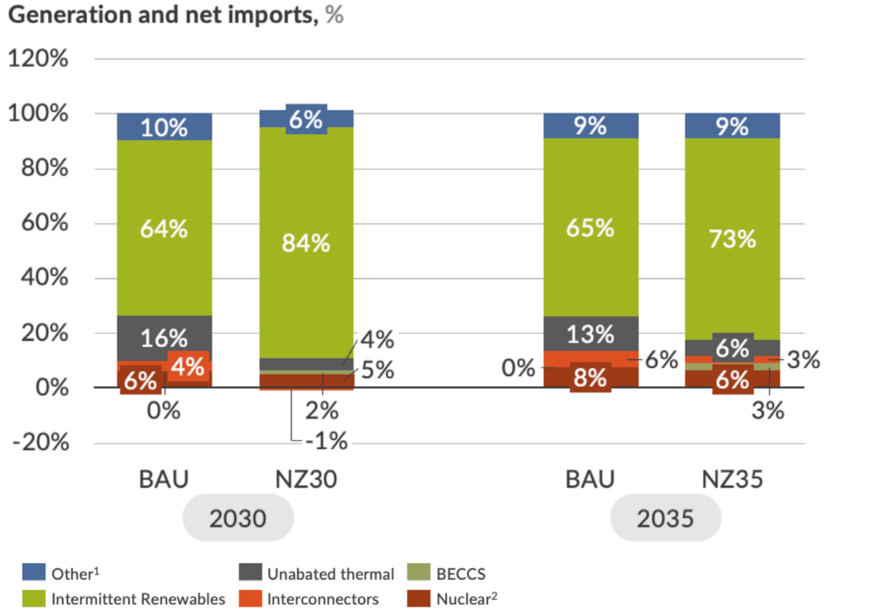
Aurora's modelling identifies that Labour's plans to decarbonise the power sector by 2030 are "infeasible in the timeframe", owing to the planning reform required, supply chain challenges and lack of skilled work force. Aurora states that "… *the extremely rapid and concurrent overhaul of the power system components would require a policy, planning and investment shift that is infeasible in the timeframe, and is unlikely to be supportable by existing supply chains and workforce skills.*"

The report argues that decarbonising the grid by 2030 is a fundamentally different proposition to decarbonising the grid by 2035. The shorter time frame risks precluding much additional generation from nuclear or bioenergy with carbon capture and storage (BECCS) from being brought online, putting more of an onus on accelerating renewable capacity and battery storage to unrealistic levels by 2030. A higher carbon price would also be required, in order to drive out unabated gas.

1. CCC (2023), 'Delivering a reliable decarbonised power system'
2. DESNEZ (2023), 'Powering Up Britain Energy Security Plan'
3. DESNEZ (2023), '2022 UK greenhouse gas emissions, provisional figures'.
4. This report focuses only on the GB power system (Conservative and Labour targets are for the UK) and excludes Northern Ireland, given that Northern Ireland is part of the Single Electricity market with the Republic of Ireland.

Reaching the Government's target of a net zero power grid by 2035 could potentially still be achieved, but would require immediate legislative reform, rapid development of onshore and offshore wind, solar, grid development and nuclear. On current trajectories the UK will not succeed in decarbonising the power sector until 2051 – 16 years later than current targets.

Figure 1.1: Generation and net imports in 2030 and 2035, across the BAU and Net Zero scenarios.



1) Includes generation from storage, demand-side response (DSR), hydrogen peaking plants, hydrogen CCGTs, biomass and gas CCS; 2.) Assumes Hinkley Point C, Sizewell C and Bradwell B delays, with an upsizing of expected future capacity.

In 2022, the amount of new low-carbon investment in the UK from the public and private sectors totalled £23bn[5]. Both the Net Zero scenarios would require a major increase in the annual level of investment, additional to current low-carbon investment in the Business as Usual scenario, to build new renewable capacity:

New Build Renewables Investment Required over the 2025-2035 period:

Net Zero 2030 scenario:

- £15.6 bn/year of additional investment until 2030 (a total of £93.5 bn)
- £4.4 bn/year of additional investment from 2031 – 2035 (a total of £22.5 bn).
- Total additional investment of £116 bn over next 11 years.

5. House of Commons Committee of Public Accounts (2023), 'Support for innovation to deliver net zero'

Net Zero 2035 scenario:

- £8.2 bn/year of additional investment until 2030 (a total of £49.3 bn)
- £11.1 bn/year of additional investment from 2031 – 2035 (a total of £55.3 bn)
- Total additional investment of £104.6 bn over next 11 years.

There is a significant difference in the pace of renewables deployment between the two Net Zero scenarios, given the need to deliver proven technologies more rapidly in the shorter timescale scenario. To deliver Net Zero 2030 would require the historical rate of solar panel deployment to more than triple and the historical rate of offshore wind deployment to increase six-fold.

- **Offshore wind**: Historic build rates of 1 GW/yr would need to increase to 3.2 GW/year (NZ 35) or 6.0 GW/yr (NZ 30).
- **Onshore wind**: Historic build rates of 0.9 GW/yr would need to increase to 1.2 GW/year (NZ 35) or 2.1 GW/yr (NZ 30).
- **Solar**: Historic build rates of 1.2 GW/yr would need to increase to 2.3 GW/year (NZ 35) or 4.3 GW/yr (NZ 30).
- **Battery Storage**: Historic build rates of 0.3 GW/yr would need to increase to 0.7 GW/year (NZ 35) or 2.5 GW/yr (NZ 30).

Additionally, an increase in transmission and distribution grid infrastructure will be necessary to support the deployment of these technologies, with both Net Zero scenarios requiring an additional 27 GW buildout on 2024 levels across key transmission corridors.[6] Net Zero 2030 will only have half the time to achieve this in.

Net Zero 2030 requires infeasibly high levels of additional investment (£15.6bn a year) over the six years to 2030. This is double the additional investment required for this period under the Net Zero 2035 scenario – and would be extremely challenging to deliver in this timescale.

Even if the funding were available, the rate of deployment reaches extreme levels, which are highly unlikely to materialise. Aurora has stated that: "*Given lead times, skills shortages, and supply chain constraints, the interventions needed for NZ 30 are likely impossible by 2030.*"

There would be significant difficulty in raising debt or equity to finance such projects in this timescale. Supply chains for steel, glass, lead, copper and aluminium would need to scale up by 250% - 400%, at a time when supply chains are increasingly constrained due to the geostrategic instability and rising global demand.

Constraints relating to planning and consenting are also a major barrier to delivering NZ 30. Lengthy planning processes mean a typical offshore wind project takes over ten years from conception to becoming operational. With only 6 years remaining until 2030, this severely limits the amount of new capacity that could be added within that scenario.

For Net Zero 2035, the rapid deployment requires a marked increase

6. Boundary B6 delineating Scotland and England and Boundary B8 delineating North of England and Midlands.

in the rate at which these technologies have been brought online to date. Aurora has stated that: "*This scenario could potentially be achieved if coherent policy action, market design and financial support is enacted at a large scale and high speed.*"

Aurora's modelling shows that the Net Zero scenarios would have significant carbon emission savings compared to the BAU Scenario.

Total Carbon Emissions for each scenario over the 2024-2050 period

- BAU = 422 Mt CO2
- Net Zero 2030 = *negative* 192 Mt CO_2
- Net Zero 2035 = 137 Mt CO_2

For comparison, in 2020, the UK's total net carbon emissions[7] were 405.5 Mt CO_2, meaning that moving from the BAU to the Net Zero 2035 scenario would reduce the UK's carbon emissions – over the next 25 years – by the equivalent of 70% of the total carbon emissions produced in 2020.

A Net Zero power sector will act as a linchpin to decarbonising other sectors, from heat in buildings to electric vehicles in the transport sector, propelling us forward to reaching Net Zero by 2050 while enabling greater energy security.

This report, in conjunction with data and modelling provided by Aurora Energy Research provides a rigorous analysis of three different scenarios, with Net Zero 2030 and 2035 scenarios showing technical routes to reach a Net Zero power sector, scrutinising their feasibility and highlighting policy measures that require implementation – as well as setting out the capital investment required and carbon reductions achieved by each route.

The transition to Net Zero is the presiding technological challenge of our time. With strong public support for the overall aims and objectives, it is vital that ambitious targets are accompanied by credible delivery plans that can be achieved in practice. Equally, where there is debate over the optimum pathway for decarbonisation, politicians from all parties should be open with the public as to the costs, benefits and challenges that will result from different decisions. Only a robust, operational programme of delivery, that takes into account the necessary system changes and is backed by the required investment, is likely to deliver the decarbonisation goals that have been set out.

7. BEIS (2020), '2020 UK Greenhouse Gas Emissions, Final Figures'

2. Key Policy Reforms Required

Irrespective of the target set for reaching Net Zero, more is needed to accelerate the decarbonisation of the power grid. We set out the following policy recommendations across a range of thematic areas.

Renewable Deployment

1. Set out a clear timetable, target capacity and forecast budget allocation for at least the next three annual auction rounds for the Contract for Difference (CfD) scheme in advance of the conclusion of the current round (AR6). This will provide clarity to the pipeline of projects looking to deploy ahead of 2035, at the latest.
2. Confirm the reforms that will be taken forward to the existing Contract for Difference design (as set out in the recent Review of Electricity Market Arrangements publication) by autumn 2024 to avoid ongoing uncertainty.
3. If it is to be taken forward, outline a timeline for implementing the move to a form of locational pricing as soon as possible, including how existing assets will have their subsidy contracts grandfathered. There should also be a clear assessment published on why the shift to locational pricing is better value for money for consumers than other system reforms.

Firm power and flexibility

4. The Government should set out a forecast (in partnership with NG ESO) that sets out the assumed electrification pathway and timetable for key sectors, such as heat, transport and industry. This matters given it impacts the generation required. The trajectory should also include the level of demand-side flexibility being assumed as a key route to reducing the level of generation required.
5. Commit to bring forward at least one further large-scale nuclear plant by the end of 2025, as well as shortlist and sign agreements in principle with at least 2 SMR projects by the end of 2024.
6. Commit to bringing forward a set amount of gas-CCS (or hydrogen power) projects by 2030, setting out a shortlist of eligible projects as soon as is possible.
7. Outline the costs and benefits of supporting a set requirement of BECCS needed for 2035, as well as how this compares to the alternative potential sources of negative emissions to offset residual emissions in the power sector.

8. Urgently clarify the new subsidy framework to support the deployment of long-duration storage, and commit to the first allocation of the chosen mechanism to be made by the start of 2025 at the latest.

Accelerating Grid Build Out

9. Implement further reforms to deal with the near 400 GW queue[8] of transmission connected projects, including consulting on the case to move to a system where additional charges are placed on inactive projects, or a fuller market for connection contracts is created.
10. Bring forward the publication of the first full iteration of the Strategic Spatial Energy Plan to the end of 2024 to provide earlier certainty to the supply chain and TSOs on new connections.
11. Urgently finalise the framework for community benefits in relation to transmission infrastructure, determining the necessary changes by autumn 2024 at the latest.

Planning and Regulatory Reform

12. Create a level-playing field for all onshore energy technologies from a planning perspective, including onshore wind, as well as committing to not changing rules around the treatment of agriculture land to make the deployment of ground-mounted solar more challenging.
13. Consider further changes to permitted development rights and local planning rules to smooth the development of on-site, low-carbon energy assets at manufacturing and industrial sites.
14. Adjust Ofgem's regulatory duties to more clearly state the importance of enabling investment ahead of need, including in shared assets (such as electricity transmission and distribution reinforcement).

Governance

1. Political commitments to Net Zero targets should be credible, deliverable and provide both certainty to industry and transparency to the public.
2. Government should require The Future Systems Operator to commit to publishing a twice annual outlook for the power sector, including the likelihood of reaching the government's stated goal for reaching a net zero power system.
3. Within its manifesto, the Labour party should set out a clear set of responsibilities and powers that GB Energy will have, including how it interacts with other proposed institutional changes (such as the creation of a National Wealth Fund).

8. Ofgem (2023), 'Ofgem announces tough new policy to clear 'zombie projects' and cut waiting time for energy grid connection'

3. Introduction

The UK's decarbonisation of the power sector has been a success story, with the sector's overall emissions intensity having reduced by 69% since 2010,[9] one of the fastest decarbonisation rates globally. This has been due to both gas and renewables displacing coal in the 1990's and 2010's respectively, to the point that coal now only contributes to approximately 2% of the UK's power mix. Low carbon generation accounts for over half of our annual electricity generation, with approximately 40% of the UK's power coming from renewables in 2021.[10] This rate of growth has in part been stimulated by the falling capital costs of developing renewable generation and policy mixes.

Consequently it has enabled the UK's emission intensity from the power sector to hit 200 gCO_2/kWh in 2021, a reduction of 60% since 2010.[11] Coupling this with a reduction in the UK's overall energy demand (down 13% since 2010), due to energy efficient appliances and lighting, has enabled our 69% reduction since 2010.[12] The challenge now for government, industry and policy makers is to decarbonise the remaining and most difficult third of the UK's electricity generation mix, while maintaining both energy security and protecting consumers energy bills.

Achieving a decarbonised power system fundamentally underpins the UK's ability to reach Net Zero by 2050. Decarbonising other sectors, such as transport and heating, will require a shift from fossil fuels (e.g. internal combustion engine vehicles and gas boilers) to alternatives which are powered by electricity (e.g. electric vehicles and heat pumps). For this reason, decarbonising electricity generation is the lynch-pin of the wider energy transition.

In addition to reducing carbon emissions, a decarbonised power system also brings wider benefits – as well as some challenges. It reduces the UK's dependence on imported oil and gas, and in turn our exposure to volatile international prices and to despotic regimes. Renewables are now cheaper than most fossil fuel generated electricity and by increasing the share of affordable, domestically generated electricity it improves our energy security. Coupled with providing job opportunities and supporting economic growth, given all sectors rely on energy to some degree.

However, the transition to renewables also brings challenges, particularly related to intermittency and reliability of supply. The different options to address this – storage, nuclear, gas with carbon capture and bioenergy with carbon capture and storage – bring differing trade-offs of cost and feasibility. While the UK should look to remain integrated to the global energy market as it enables diversity and reliability of supply. Integration

9. CCC (2023), 'Delivering a reliable decarbonised power system'
10. DESNEZ (2023), 'Powering Up Britain Energy Security Plan'
11. Ibid.
12. Ibid.

acts as a form of insurance, where supply and price shocks caused by political tensions or extreme weather periods can be spread across the international market and felt less intensely by individual countries.

Under almost all feasible scenarios, the development of the UK's future energy system will be one that maintains a diverse portfolio of generation capabilities, to ensure resilience in the face of potential project delivery delays and technology failures. Retaining optionality of generating technologies will help mitigate against the risks of delivery and deployment. Equally the future energy system should be designed to withstand shocks from intense weather events, such as flooding, extreme heat and fluctuating wind speeds, that are becoming more common place as the impacts of climate change are coming to bear. This will be essential as society becomes more electrified, with critical services such as medicine, banking and telecommunications already reliant on a stable supply of electricity. Gas will still be required in our system to a degree, namely to provide energy security in times of low renewable energy generation and peak energy demand. The role of gas in the power sector is one of the considerations as the UK wrestles with the pace of decommissioning its gas infrastructure. This will be complemented and eventually phased out by low carbon energy storage, such as hydrogen and batteries. Technology optionality should also be accounted for, giving consideration to whether it is better for our energy system to build low carbon generation with shorter development times, or invest in projects that have longer lead times (e.g,. nuclear) but will provide better energy security.

Both the Conservative and Labour party have agreed to support the 2050 Net Zero target, that was legislated for by the UK Parliament in 2019 and therefore this report takes as a premise that meeting the 2050 target is a shared national objective across the political spectrum. As a stepping stone to this objective, the Climate Change Committee has identified 2035 as the optimal time frame to deliver a decarbonised energy grid, which if overrun then naturally will have knock on consequences to other decarbonisation targets proposed across the transport, building and industrial sectors, and the 2050 Net Zero target. The Conservative Party has accepted this target of 2035; however, Labour has set out a more ambitious target, wishing to achieve a decarbonised power sector by 2030.

It should be noted that under current models[13] – including our own – the UK is not on track to achieve either the 2030 or 2035 target with the current rate of deployment. To achieve either 2030 or 2035, in line with increasing electricity demand, will require significant growth in renewable generation, acceleration of planning and consenting arrangements, expansion of the grid network (transmission and distribution), robust supply chains, with investment and action from both the public and private sector.

We believe that the debate over how and how fast to achieve Net Zero should be informed by the best possible evidence, while politicians should face scrutiny on the promises they make, particularly in an election year. The pathway to Net Zero will be heavily determined by the target set, with

13. CCC (2023), 'A reliable, secure and decarbonised power system by 2035 is possible – but not at this pace of delivery'.

early dates closing off some technology options, and later dates potentially leading to knock-on negative consequences for industrial transition jobs and growth, as well as imperilling our ability to hit the Net Zero target of 2050.

We have therefore commissioned Aurora Energy Research to provide an analysis of three different scenarios in which Great Britain could reach a Net Zero power sector, to cut through the political rhetoric and to understand what policy changes would be necessary to reach each party's stated target.

- **Net Zero 2035 (NZ 35):** a scenario aiming to deliver Net Zero in the power sector by 2035, in line with the target announced by the Conservative Government, and recommended by the independent Climate Change Committee.
- **Net Zero 2030 (NZ 30):** a scenario aiming to deliver Net Zero in the power sector by 2030, in line with the target announced by Labour.
- **'Business-As-Usual':** a scenario following the current trajectory of policy development and market environment for the GB power sector.

Aurora's in-house modelling of the power the sector has enabled them to provide a robust analysis and modelling of the three scenarios. To provide this they have researched and applied the latest data from technology deployment, policy and regulation, demand, real weather data and the commodities market, enabling an independent set of analysis of the power sector. For an overview of the modelling please refer to Aurora's 'Pathways and challenges to decarbonising the GB power sector' report, published alongside this document.

The Net Zero 2030 and 2035 scenarios represent technical routes to reach a Net Zero power sector, while highlighting the practical limitations and barriers preventing their implementation. The scenarios are not predictions of how the power sector will develop. Additionally, this report focuses only on the GB power system (Conservative and Labour targets are for the UK) and excludes Northern Ireland, given that Northern Ireland is part of the Single Electricity market with the Republic of Ireland. This approach is consistent with other reports, such as the CCC's report on 'Delivering a reliable decarbonised power system'.[14]

14. CCC (2023), 'Delivering a reliable decarbonised power system'

4. Current Commitments to a Decarbonised Electricity Sector

Government – 2035 Target

The Government has committed to a fully decarbonised power system by 2035, subject to the security of supply, as stated in their Net Zero Strategy: Build Back Greener (2021). The goal is for electricity generated to come from low carbon sources, while acknowledging that an increase in investment to grid network, electricity storage solutions and flexible grid management are required, to ensure decarbonisation without risking security of supply. The Government however, has not defined their 'security of supply' or stipulated the volume of residual CO_2 emissions it is willing to accept from unabated gas, which will be used to meet shortfalls in supply during occasions of variable energy generation. The CCC suggests that a small volume of unabated gas may still be needed to provide electricity on rare occasions, to meet demand requirements, up to 2% of annual electricity production in 2035.[15] While in March this year the Government announced plans to build new gas power stations, justified by the need to maintain energy security when renewable generation is low due to weather conditions.[16]

Government's decarbonisation commitments are to meet its forecasted electricity demand increase of 40-60% by 2035, as both the heat and transport sectors become more electrified. This report has refined this estimation and modelled electricity demand to increase by 29% (at 396TWh pa) in the Current Pathway or 43% (to 453 TWh pa) in both the 2030 and 2035 pathways, on 2024 levels, namely due to the electrification of heat, transport and hydrogen production via electrolysis.

To support reaching the 2035 target, the Government has set a number of key milestones in their Net Zero Strategy and Energy Security Plan, Powering Up Britain (2023) and surmised below. However, evidence submitted to the House of Commons BEIS Committee 2022-23 report on 'Decarbonisation of the Power Sector' argued that if Government continues operating in a 'business-as-usual' fashion and with the current rate of policy delivery, then it will fail to reach its 2035 target. The modelling commissioned for this project confirms this.

- **Offshore Wind Capacity**: The Government plans to have up to 50 GW capacity by 2030, including up to 5 GW floating wind. The UK currently has 14.7 GW of offshore operational capacity[17]

15. CCC (2023), 'Delivering a reliable decarbonised power system'
16. Gov.UK (2024), 'Press Release: Energy Secretary takes action to reinforce UK energy supply'.
17. RenewableUK (2024), 'Wind Energy Statistics'

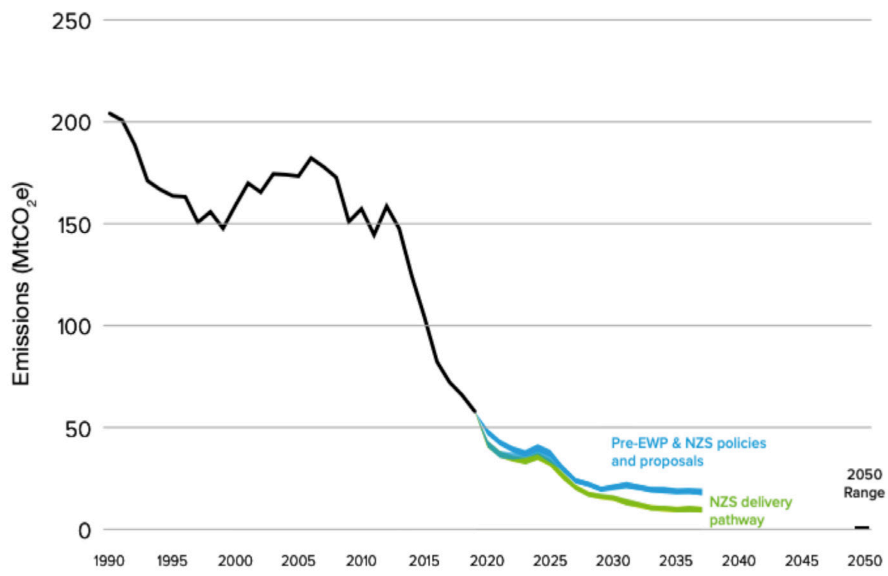
and will need to install an average of 5 GW per year to hit its 2030 target. This build rate is above historic averages, with 2022 showing to be a record annual high of 3.2 GW new capacity installed.[18] However this year's CfD auction (Allocation Round 6) will have 14 wind farms (10.3 GW) eligible to bid for contracts, breaking the previous record in 2022 where 7 projects (8.5 GW) were eligible to bid.[19]

- **Onshore Wind Capacity**: The Energy Security Strategy does not include a specific target for onshore wind, with the BEIS committee report highlighting that onshore wind is a missed opportunity in government's decarbonisation strategy.[20]
- **Solar Capacity:** Government plans to increase solar capacity fivefold to 70 GW (roof and ground mounted) of solar by 2035. This will require an installation rate of 4.3 GW of solar per year, with 4.1 GW of solar developed per annum historically.[21]
- **Nuclear Capacity**: The UK has an existing fleet capacity of circa 6 GW, comprising of 4 Advanced Gas-cooled Reactors (AGR) and a Pressured Water Reactor (PWR), Sizewell B. The AGR fleet is expected to close between 2026-2028, with Sizewell B scheduled to come offline in 2035, which may be extended pending EDF's feasibility study.[22] Government's ambition is for 24 GW of nuclear power by 2050, with Hinkley Point C (HPC) and Sizewell C (SZC) currently under development and expected to produce 3.2 GW each. EDF estimates HPC's 1st unit (1.6 GW) to be operational at some point between 2029 - 2031[23] and Government expects SZC to come online in mid 2030's. Aurora's modelling assumes 2030 for HPC's first reactor and 2037 for SZC.
- **Hydrogen Capacity:** Ambitions for up to 10 GW of low-carbon hydrogen production capacity by 2030 with at least half from electrolytic hydrogen. Up to 50% of the 2030 hydrogen production ambition depends on Carbon Capture Use and Storage (CCUS).[24]
- **CCS Capture Rates**: To capture 20-30 million tonnes of CO_2 per year by 2030.
- **Interconnector Capacity:** As of 2024 the UK operates 6 interconnectors, exchanging 7.8 GW of power between Great Britain and Europe,[25] this is a near threefold increase in capacity since 2010.[26] Government has an ambition to achieve 18 GW by 2030.

In addition to these generation targets Government has set in law the legally binding Carbon Budget 6 (CB6) to reduce emissions 78% by 2035 compared to 1990 levels, incorporating international aviation and shipping emissions.[27] The power sector will contribute to CB 6, with Government expecting sector emissions to reduce 71-76% by 2030 and 80-85% by 2035, compared to 2019 levels, as shown in Figure 4.1.[28] Government have accepted that there will be an expected residual level of emissions generated, limited to CCUS plants, unabated gas and energy from waste.

18. RenewableUK (2023), 'Press Release'
19. RenewableUK (2024), 'Press Release'
20. BEIS Committee (2023), 'Decarbonisation of the power sector'
21. CCC (2023), 'Delivering a reliable decarbonised power system'
22. DESNEZ (2024), 'Civil Nuclear Roadmap to 2050'
23. World Nuclear News (2024), 'EDF Announces Hinkley Point C Delay'
24. HM Government (2023), 'Carbon Budget Delivery Plan'.
25. National Grid (2024), 'Energy Explained'
26. BEIS (2022), 'Electricity interconnectors in the UK since 2010'
27. BEIS Press Release (2021), 'UK enshrines new target in law to slash emissions by 78% by 2035'.
28. BEIS (2021), 'Net Zero Strategy: Build Back Greener'

Figure 4.1: Indicative power emissions pathway out to 2037.



EWP = Emissions White Paper NZS = Net Zero Strategy

Labour – 2030 Target

Labour have set a more ambitious target of a zero carbon electricity system by 2030 as outlined in their '[Make Britain a Clean Energy Superpower]' plan, this is also phrased as '100% clean power by 2030' on the [Party's website]. Neither a 'zero carbon electricity system' or '100% percent clean power' is explicitly defined within their plan, however there are a series of goals Labour outline across renewables, nuclear, CCS, hydrogen, other storage and gas (within a strategic reserve capacity). This report interprets Labour's target to be a fully decarbonised electricity grid, the same as the current Government's, simply 5 year earlier, given that achieving a 100% clean power grid is significantly more complex, costly and energy insecure.

Labour have stated they will headquarter their new national energy company – GB Energy -in Scotland (with its own specific delivery plan) and if successful in the forthcoming election, will deliver the following to reach their target:

- **Offshore Wind**: Quadruple offshore capacity, with an ambition of 55 GW by 2030. Pioneer floating offshore wind, fast-tracking at least 5 GW of capacity.
- **Onshore Wind**: Overturn the current ban in England and more than double the UK's onshore wind capacity to 35 GW.
- **Solar:** More than triple solar power to 50 GW.
- **Nuclear:** Get new nuclear projects at Hinkley and Sizewell over the line, extending the lifetime of existing plants, and back new nuclear including SRs.

- **Hydrogen:** 10 GW of hydrogen production for use particularly in flexible power generation, storage, and industry, such as green steel. Through its National Wealth Fund, £500m investment into green hydrogen over parliament.
- **Storage:** Invest in carbon capture and storage, hydrogen and long-term energy storage to ensure that there is sufficient zero-emission back-up power and storage for extended periods without wind or sun.
- **Back Up Gas:** Maintaining a strategic reserve of backup gas power stations to guarantee security of supply
- **Planning System:** To reform, updating the National Planning Policy Statements and Nationally Significant Infrastructure Projects.
- Establish a **National Wealth Fund**, enabling investments into ports, gigafactories, clean steel, industrial clusters, and hydrogen. At Labour's 2022 conference an initial portfolio of investments was outlined, including:
    - Investing £1.8 bn over the next parliament to upgrade ports to be renewable ready.
    - £2.5 bn investment over a decade to transition the steel industry.
    - Decarbonising industrial clusters, with additional investment of £1 bn over the parliament.
    - £1.5 bn investment into gigafactories over the parliament to support the automotive industry.
- Establish **GB Energy**. A publicly owned clean energy generation company, headquartered in Scotland.
- Implement their **Rewire Britain** plan – to address planning and grid constraints.
- Deliver their **Warm Homes Plan**, to insulate 5 million homes by 2030.

Labour have also estimated they will be able to cut energy bills, reducing the average annual household bill by £1,400 and £53 bn off energy bills for businesses by 2030 (see box below). Labour have arrived at their household forecast by combining the future gas price projections and their Warm Homes plan. By comparison a British Gas report[29] this year shows the average annual household gas and electricity bill for direct debit customers of a 3 bedroom house, to be £2008.69.

Figure 4.2: Extract from Labour's Make Britain a Clean Energy Superpower Plan.

Achieving the mission

Clean power by 2030

Labour will take up to £1,400 off the annual household bill and £53 billion off energy bills for businesses by 2030, by **delivering a cheaper, zero-carbon electricity system by 2030.**

29. British Gas (2024), 'What is the average energy bill in Great Britain?'

As of February 2024, Labour rowed back on their £28 bn a year spend on environmental projects, equating to a £4.7 bn per year funding package. It is difficult to assess what consequences this will have on their energy plan as the party has not said precisely what the funding would be assigned to.

However, to date Labour has announced they will create a state owned energy company, GB Energy (initial £8.3 bn cost), a national wealth fund (£7.3bn) to invest in decarbonising heavy industry and keep its 2030 target for a 'zero carbon electricity system'. These are the some of the key differences that sets Labour's energy plan apart from the Conservatives, while they have also pledged to overturn the de facto onshore wind ban, end new North Sea oil and gas exploration and lift the North Sea levy from 75p to 78p, while extending the end date from 2028 to 2030.

5. Annual Power Demand Assumptions

Through Aurora's modelling, GB's annual power demand within the Business-as-Usual (BAU) scenario will reach 396 TWh by 2035. This is a 29% increase from 2024 (307 TWh). Base power demand remains relatively consistent over the coming years, with the increase in demand attributed to a growth across both the heat and transport sectors.

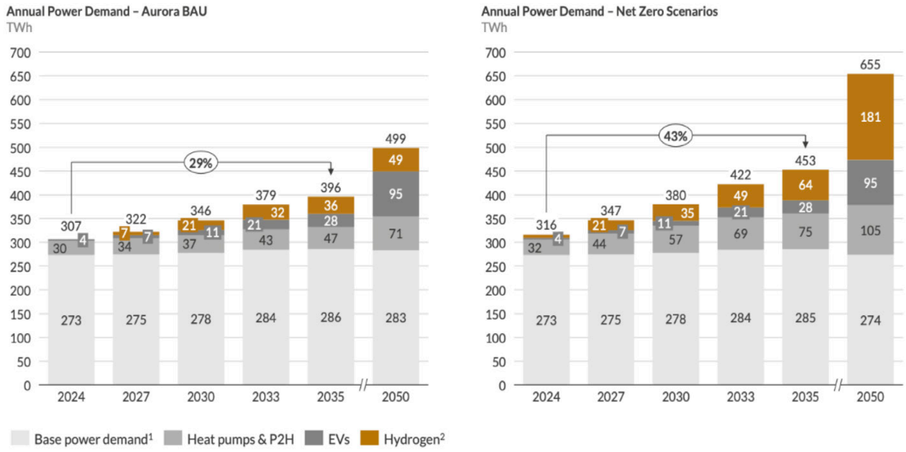
By comparison, the CCC assumes in their 'Delivering a reliable decarbonised power system' report, that demand in 2035 will increase by 50% from pre covid levels[30], with total demand in the Balanced Pathway reaching over 450 TWh in 2035. National Grid ESO also holds a similar estimation, who in their 'A Day in the life of 2035' report[31] forecast electricity demand to be 475 TW in 2035.

For similar reasons, the annual power demand in both of Aurora's Net Zero scenarios increases 43% in the same time frame to reach 453 TWh in 2035. Our forecast demand is broadly consistent with, though slightly lower, than that predicted by National Grid ESO and the CCC.

This greater increase in demand within Aurora's model is driven by the assumption that a wider and more stringent decarbonisation would accompany the drive to Net Zero within the power sector. For example, within the Net Zero scenarios there will be a greater availability of renewable and low carbon electricity generated, to which Government and industry will wish to maximise the use of through deploying a greater number of electricity driven applications, rather than curtailing renewable power during periods of high generation. Similar to the CCC's estimation of future electricity demand[32], this report predicts that GB will likely see a greater electrification of heat (heat pumps), transport (EVs) and increased electrolysis of green hydrogen, all contributing to the rise in electricity demand. There will also inevitably be a potential increase in electricity exports, subject to how the demand side of the equation plays out.

30. CCC (2023), 'Delivering a reliable decarbonised power system'
31. National Grid ESO (2022), 'A day in the life of 2035'
32. CCC (2023), 'Delivering a reliable decarbonised power system'

Figure 5.1: Annual power demand increase for BAU and both Net Zero scenarios.



1) Underlying power demand excluding heat, hydrogen and transport; 2) Demand for Green hydrogen production from electrolysis.

6. Business-as-Usual Scenario

Under the current market framework and with no new direct policy intervention, Great Britain is forecasted to reach a Net Zero power sector by 2051. This is due to the difficulties in deploying renewable energy systems and their enabling technologies, particularly because of planning delays, network build out rates and finance mobilisation acting as key limiters. Under BAU, the power sector is forecasted to see a reduction in net emissions by 53% over the period 2024-2035, to 18.1 $MtCO_2e$, which by context is a 97% reduction from 1990 levels[33]. This scenario fails to meet the government's current Net Zero target and will produce a total of 422 Mt CO_2 for the period 2024-2050. For context, in 2020, the UK's total net carbon emissions were 405.5Mt CO_2[34].

Figure 6.1: BAU forecasted power sector carbon emissions.

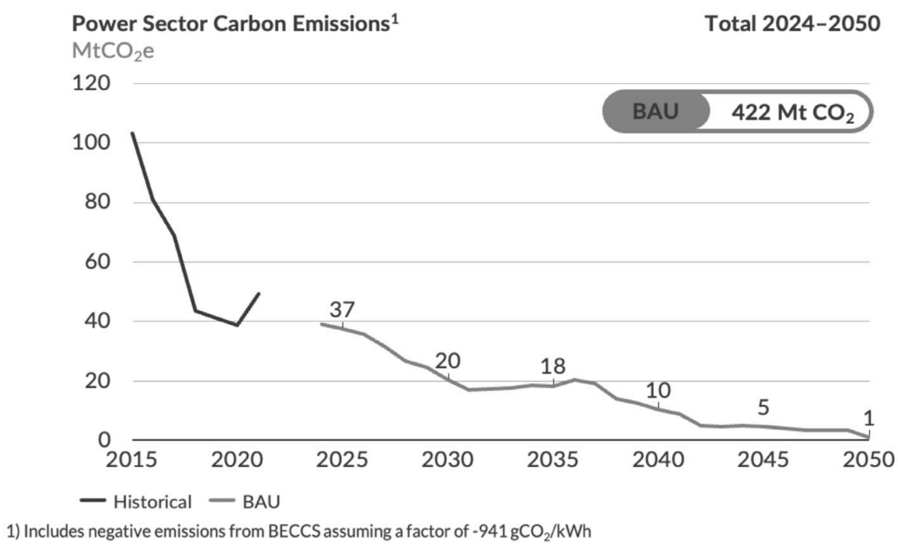
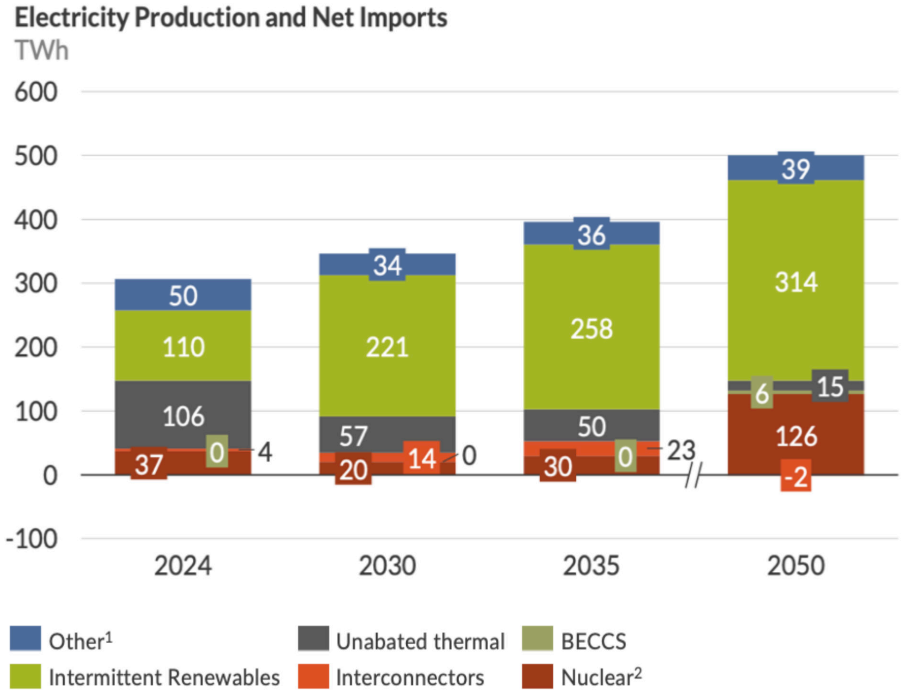


Figure 6.2 represents electricity production within the BAU scenario out to 2050, where it assumes a development trajectory of technology capacities based on existing and announced policy, the likelihood of their implementation and asset economics. The greatest proportion of the energy mix in 2050 consists of intermittent renewables[35] (63%), delivering 314 TWh of electricity, with nuclear contributing 126 TWh and making up 25% to the energy mix. A small degree (3%) of unabated thermal generation[36] has remained, delivering 15 TWh. This source of firm power is necessary to maintain energy security and deliver power during periods of peak demand when other clean energy sources cannot meet peak demand levels.

33. Based on energy sector greenhouse gas emissions of 614.8 $MtCO_2e$ in 199, as published by BEIS, April 2021.
34. UK Government. Link
35. Intermittent Renewables: offshore wind, onshore wind and solar.
36. Unabated thermal includes coal, gas CGGTs, CHP, biomass, gas and oil peakers.

Figure 6.2: BAU Scenario electricity production and net imports.



1) Includes generation from storage, demand-side response (DSR), hydrogen peaking plants, hydrogen CCGTs, biomass and gas CCS; 2.) Assumes Hinkley Point C, Sizewell C and Bradwell B delays, with an upsizing of expected future capacity.

7. Generation Build Rates

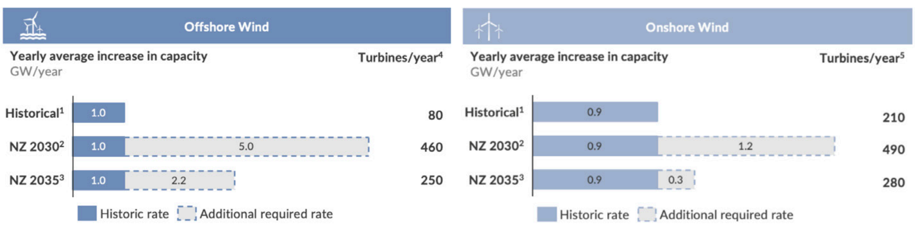
Each of the three scenarios will require a diverse energy mix, regardless of their respective Net Zero targets, while each of the technologies employed have their own specific barriers to delivery. The purpose of this section is to analyse the historic build rates for the generation technologies and the increased rate of build out required to meet both 2030 and 2035 targets, while highlighting the specific barriers each of the technologies face.

Renewables

Offshore Wind: The UK has been a pioneer in the large scale offshore wind industry, yet to reach decarbonisation goals we would need to accelerate its average yearly increase in capacity, which sits at 1 GW/year. To reach NZ 2035 it would need to deliver 3.2 GW on new offshore wind capacity per year, a 2.2 GW increase on current levels. NZ 2030 will require a much greater annual delivery, with 6.0 GW/year required, a 5.0 GW increase on current levels.

Approximately two thirds of the development pipeline of new offshore wind projects can be attributed to the complex early stage planning and consenting process, the required environmental impact assessments and a complex Offshore Transmission Owner (OFTO) regime. Additionally there is also a degree of uncertainty to what revenues will be generated from offshore wind projects, given the Review of Electricity Market Arrangements (REMA) consultation, hindering investment.

Figure 7.1: Offshore and onshore wind annual average capacity increases required to meet NZ targets.



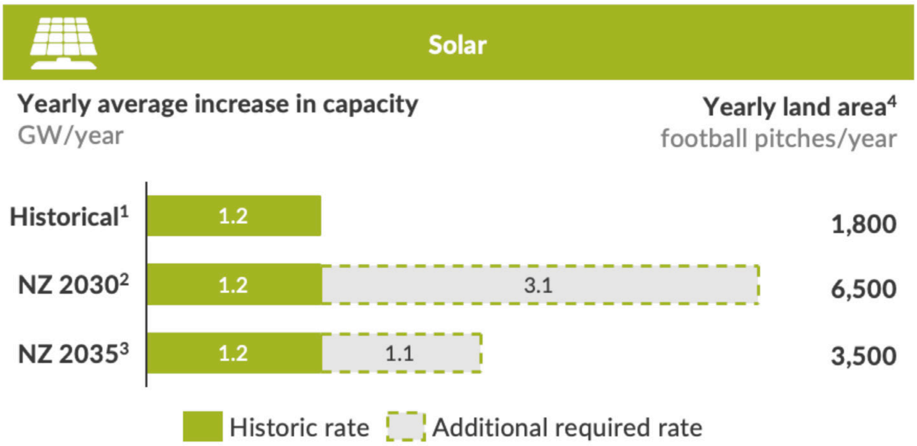
1) Average annual increase calculated from 2013–2023; 2) Average annual increase calculated from 2025 to 2035; 3) Average annual increase calculated from 2025 to 2030; 4) Based on 13MW turbine; 5) Based on 4.3MW turbine.

Onshore Wind: The current planning and permitting bottlenecks are acting as key limiters on developing of new onshore wind projects, creating a defacto ban in England and Wales. This has stalled onshore wind growth, with 1.4 GW of new capacity in the past 5 years (2019

= 12.2 GW to 2023 = 13.6 GW). In order for GB to reach its Net Zero targets it will need to achieve an annual capacity build rate of 1.2 GW/year for NZ 2035 and to 2.1 GW/year for NZ 2030.

Solar: The historic rate of growth sits at 1.2 GW/year of new solar capacity, with growth in the sector stalled due to planning and grid connection issues, namely across England and Wales. To reach NZ 2035 solar development will need to increase by an additional 1.1 GW/year and by 3.1 GW/year to achieve NZ 2030.

Figure 7.2: Solar annual average capacity increases required to meet NZ targets.

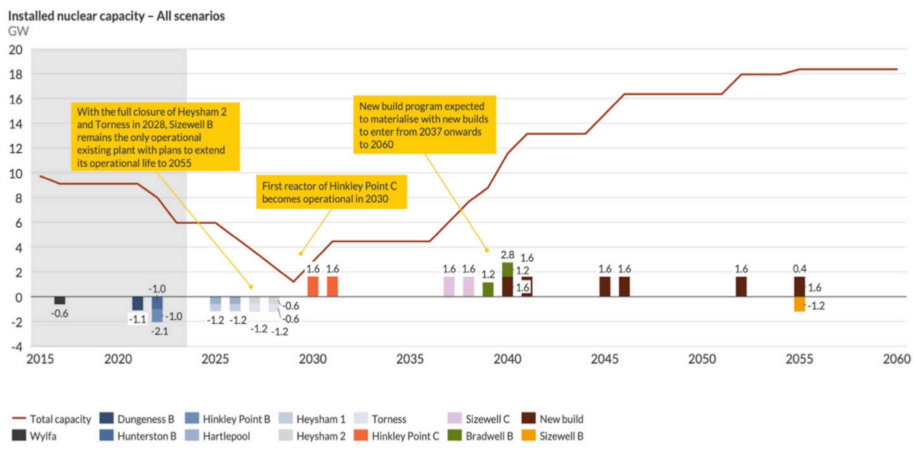


1) Average annual increase calculated from 2013 – 2023; 2) Average annual increase calculated from 2025 to 2035; 3) Average annual increase calculated from 2025 to 2030; 4) Based on 3 acres/MW.

Low Carbon Power

Nuclear: Nuclear power will serve as GB's base load power, however no acceleration of nuclear development is considered, given the recent delays of Sizewell C and 19-year development timeline for large nuclear plants.

Figure 7.3: Assumed installed nuclear capacity across all three scenarios.



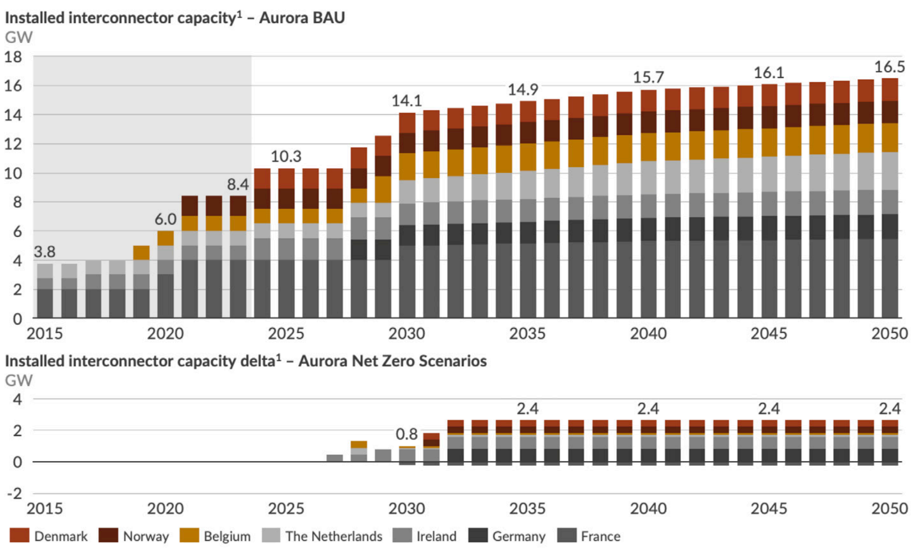
1) Line chart represents end-of-year capacity.

Between 2024 and 2035 nuclear power generation is set to fall from 37 TWh to 30 TWh of generation. This reduction is due to a combination of Heysham 2 and Torness completely closing down in 2028 and delays in Hinkley Point C construction, where it is assumed the first rector will become operational in 2030. Aurora's modelling expects to see 2.8 GW in 2030 and 4.5 GW of capacity in 2035. It is infeasible to develop a concurrent construction plan that would have any impact prior to 2030 or 2035, namely due to a shortage of skilled workers. It is further assumed that Sizewell B's operational life will be extended to 2055, with the new build program and Bradwell B expected to come online between the period 2037-2060, delivering 13.9 GW of new build capacity beyond Hinkley Point C. This will bring GB's nuclear installed capacity to just above 18 GW by 2060.

Flexible Capacity

Interconnectors: GB's interconnector deployment has been supported by the Government's backed cap and floor mechanisms, however there are a number of uncertainties surrounding interconnector deployment. Beyond the projects already under construction, Aurora modelling identified that it is possible for three more projects to be deployed up to 2030, one each in Belgium, the Netherlands and France. These three projects are currently in development and are derated[37] in Aurora's modelling, according to their development stage to reflect historic success rates. It is therefore assessed that 14.1 GW of installed capacity by 2030 (3.1 GW less than the current Government's ambition of 18 GW by 2030)[38] and 16.5 GW by 2050. The capacity build out rate from 2030 to 2050 is gradual and in line with expanding renewable capacities.

Figure 7.4: Forecasted interconnector capacity for BAU and NZ scenarios.



1) Based on end-of-year capacity.

37. Derated: Interconnectors operating at less than their maximum capacity.
38. DESNEZ (2023), 'Powering Up Britain Energy Security Plan'

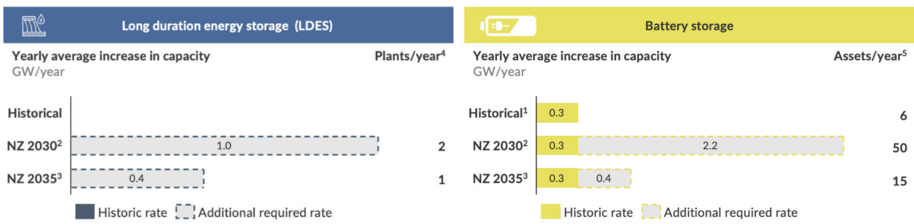
Interconnectors are a technology in the energy mix where the deployment rates do not require accelerating across either of the NZ scenarios. Figure 7.4 reflects that in both Net Zero scenarios there will be an increase in capacity by 0.8 GW in 2030 and 2.4 GW by 2050. This additional capacity would enable GB to capitalise on a greater volume of renewable energy generated abroad, especially during periods of low domestic production and a surplus generation abroad, reducing the requirement to rely on unabated gas generation from the capacity market.

The total level of imports will be reduced across each of the NZ scenarios, however interconnection will still be a vital necessity in order to maintain energy security. There remains a possibility of carbon leakage occurring through interconnectors, however Aurora's modelling assumes that imports are often from low carbon and cheaper sources, and should not represent a significant shift in emissions.

Long Duration Energy Storage (LDES)[39]: There is not a sufficient number of projects and data to provide a historical build rate for LDES technologies, such as hydrogen storage. Regardless LDES will be required in the future, with 8 GW in the NZ 2035 scenario, in order to provide a flexible system that can store excess electricity generated by renewable sources and utilised during periods of high demand. NZ 2030 is too near a timeframe to commission new plants based on certain LDES technologies, such as pumped hydro, given their construction timeframe is too long. Of note, consultation on the LDES cap and floor mechanism closed on 5th March 2024. The mechanism was necessary to provide long term revenue security, helping to unlock financing of large scale capital deployment.

Battery Storage: Historically GB battery storage has increased in capacity by 0.3 GW/year, requiring an addition rate of 2.2 GW for NZ 2030 and 0.4 GW for NZ 2035. It is assumed under Aurora's modelling that the 2030 target of 2.2 GW/year increase in battery capacity is achievable, provided the timings of grid connections are successful. The total level of battery connections in NZ 2030 reaches 20 GW, significantly above BAU, however still below the total 43 GW available that sits within the pipeline of potential assets in the Renewable Energy Planning Database.[40]

Figure 7.5: Battery and LDES annual average capacity increases required to meet NZ targets.



1) Average annual increase calculated from 2018 – 2023; 2) Average annual increase calculated from 2025 to 2035; 3) Average annual increase calculated from 2025 to 2030; 4) Based on Cruachan pumped storage at 440MW; 5) Based on 50MW capacity.

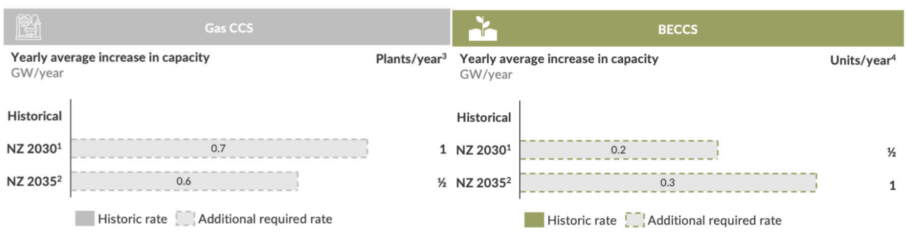
39. Long duration energy storage are technologies such as pumped hydro storage and hydrogen.
40. DESNEZ (2024), 'Renewable Energy Planning Database: quarterly extract'

Carbon Removal Technologies

Gas Carbon Capture and Storage (CCS): Dispatchable gas generation will be required for both NZ scenarios, in order to ensure energy security and provide power during peak times that cannot be delivered by renewable energy. For Net Zero, this will require an increased deployment of CCS, however this relies on deploying technology at an unproven scale or carbon capture efficiency. There are a number of support schemes, such as CCS clusters, which will help bring the technology to market. NZ 2035 entails a greater element of CCS compare to NZ 2030, given the latter target is too short a timeframe for technology development and mass deployment.

Bioenergy with Carbon Capture and Storage (BECCS): 0.3 GW/year of new BECCS capacity for NZ 2035 and 0.2 GW/year for NZ 2030 are brough online to offset the carbon emissions from unabated gas generation. The level to which negative emissions can be applied to BECCS technology is highly contested and there is currently no international standard, classification of feedstocks or process by which standards need to be conformed to. The modelling has applied an assumed level of -941 gCO_2/kWh.[41] Policy intervention is required here to provide an industry wide standardisation of negative emissions, helping to prevent the mistreatment of BECCS as an emissions reduction technology.

Figure 7.6: Gas CSS and BECCS annual average capacity increases required to meet NZ targets.



1) Average annual increase calculated from 2025 to 2035; 2) Average annual increase calculated from 2025 to 2030; 3) Based on 860MW Net Zero Teeside Power capacity; 4) Based on Drax unit converted capacity of 460MW.

41. 5) Taken as a mid-point estimate of -647 and -1137 kg/MWh in: García-Freites, S., Gough, C., & Röder, M. (2021). The greenhouse gas removal potential of bioenergy with carbon capture and storage (BECCS) to support the UK's net-zero emission target. Biomass and Bioenergy, 151, 106164.

8. Net Zero 2030 Scenario

KEY POINTS

Aurora's modelling shows that NZ 2030 is deemed an infeasible scenario, justified by an insufficient time available to conduct what would be a radical overhaul of the power system, policy, planning systems and investment landscape. The speed required to build critical technologies – including offshore wind, onshore wind and solar – would need to increase to multiple times their historical installation speed, as would investment in grid capacity.

If it were to be achieved, it would have the following impact:

CO_2 emissions:

- Net negative emissions are reached in 2031 at -0.2 Mt CO_2e.
- The total negative emissions are -192 MtCO_2e over the period 2024-2050.
- This scenario saves 614 MtCO_2e more in carbon emission compared to BAU.

Capacity Build Required:

- Renewable capacity needs to reach 118 GW by 2030, which is an additional 40 GW on the BAU scenario in 2030.
- NZ 2035 sees the following increase in **renewables** from 2024 – 2030:
    - 36 GW offshore Wind.
    - 12.6 GW of onshore Wind.
    - 26 GW of solar.
- Grid capacity across the B6 and B8 boundaries needs to reach 46 GW by 2030, an additional 20 GW on the BAU scenario in 2030.

Renewable New Build Costs Over the 2025-2035 Period:

- £15.6 bn/year of additional investment until 2030 (a total of £93.5 bn)
- £4.4 bn/year of additional investment from 2031 – 2035 (a total of £22.5 bn).
- Total additional investment of £116 bn over next 11 years.

Overview

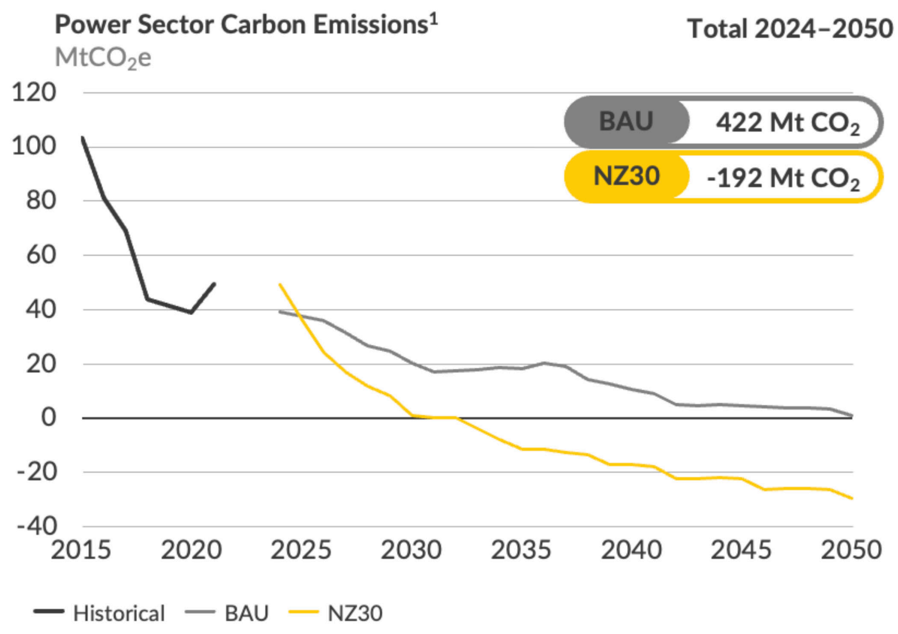
Achieving a Net Zero power system by 2030 would require significantly greater intervention compared to the NZ 2035 scenario and a radical overhaul of the power system at an infeasible rate, as detailed in Aurora's report. This scale of intervention would be necessary to increase renewable generation capacity to a required level of 118 GW by 2030, an uplift of 40 GW compared to the BAU scenario. It would also see BECCS play a key role, running at base load, due to the limited alternative options available to thermal generation.[42] In this scenario CO_2 emissions reach 0.8 MtCO_2e

42. Unabated thermal includes coal, gas CGGTs, CHP, biomass, gas and oil peakers.

in 2030 and net negative emissions achieved in 2031 at -0.2 $MtCO_2e$. For the period 2024-2050 this scenario will save 192 $MtCO_2e$, and 614 $MtCO_2e$ more in carbon emission savings compared to the BAU scenario.

The NZ 2030 scenario represented here details what would need to be deployed in a theoretical context to reach a Net Zero power system. However the modelling by Aurora shows that this is not a feasible timeline to decarbonisation the power sector, due to the required deployment of renewables, flexible generation and abated technologies alongside the removal of gas-fired CHP, means.

Figure 8.1: NZ 2030 and BAU scenario power sector carbon emissions.



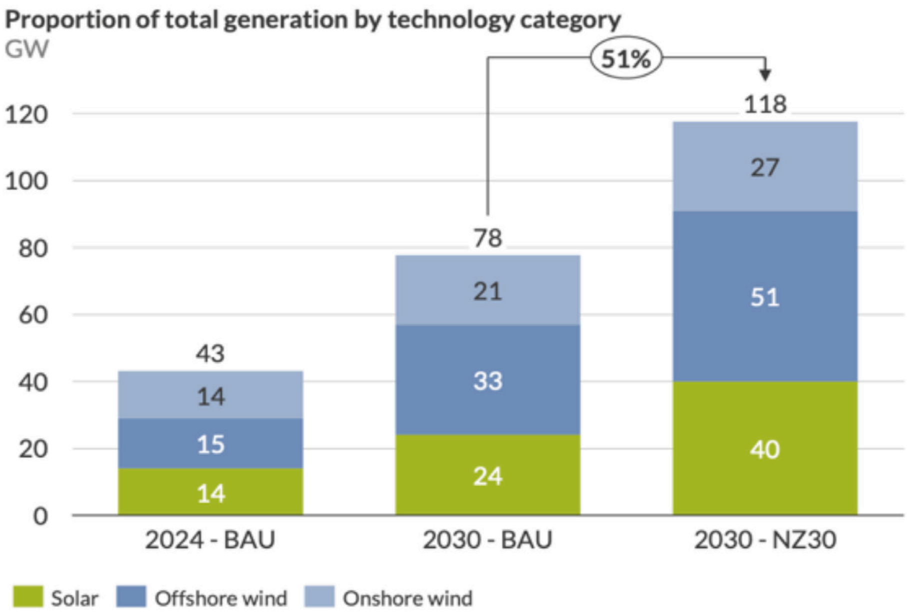
1) Includes negative emissions from BECCS assuming a factor of -941 gCO2 /kWh.

Additionally pursuing the 2030 target will result in reduced optionality, as it requires employing technologies that can be deployed at a faster rate, but which are not necessarily the optimal technology choices for a Net Zero power system.

Additional Capacity Build Required

Renewables: The renewable energy portfolio by Net Zero 2030 sees an increase to 40 GW solar, 51 GW offshore wind and 26.6 GW onshore wind. Overall this is a 51% increase in capacity relative to the BAU scenario in 2030. An increase of this capacity within this period of time, is deemed infeasible by Aurora given the timeframe, given that it would require a substantially greater rate of renewable capacity deployment than historically delivered. By example it would require offshore wind deployment to increase from a historic 1 GW/year to 6 GW/year, and solar to increase from a historic 1.2 GW/year to 4.3 GW/year.

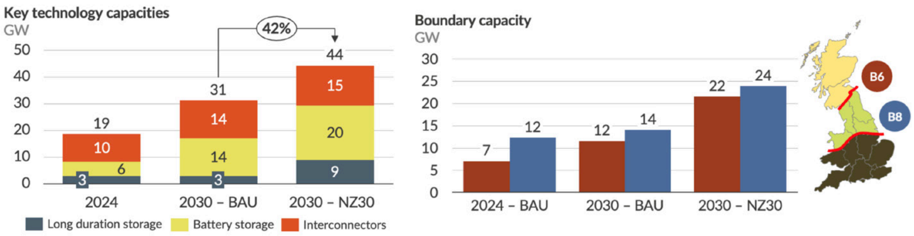
Figure 8.2: Renewable energy generation capacity increase required for NZ 2030.



Flexibility and Grid: To support the deployment of renewables, flexible technologies (LDES, battery and interconnectors) will require an uplift of 42% relative to the BAU scenario in 2030. Battery storage increases to 20 GW and is assessed that this could be reached with the timeframe, while interconnectors are also forecasted to reach 15 GW by 2030, with a +0.8 GW capacity delta. However the modelling assumes achieving 9 GW of LDES in the next six years will not be feasible, due to the planning, development and construction timeframe required.

Alongside these technologies, the grid's transmission and distribution system will need to upgrade to accommodate for additional power being fed onto the system. Boundary 6 capacity would need to accelerate to 22 GW and Boundary 8 to 24 GW, a total increase of 20 GW on the BAU scenario. Again due to long planning timelines and supply chain constraints, this increase in capacity is deemed infeasible by the modelling.

Figure 8.3: Flexible technology and grid capacity build out rates under BAU 2030 and NZ 2030.

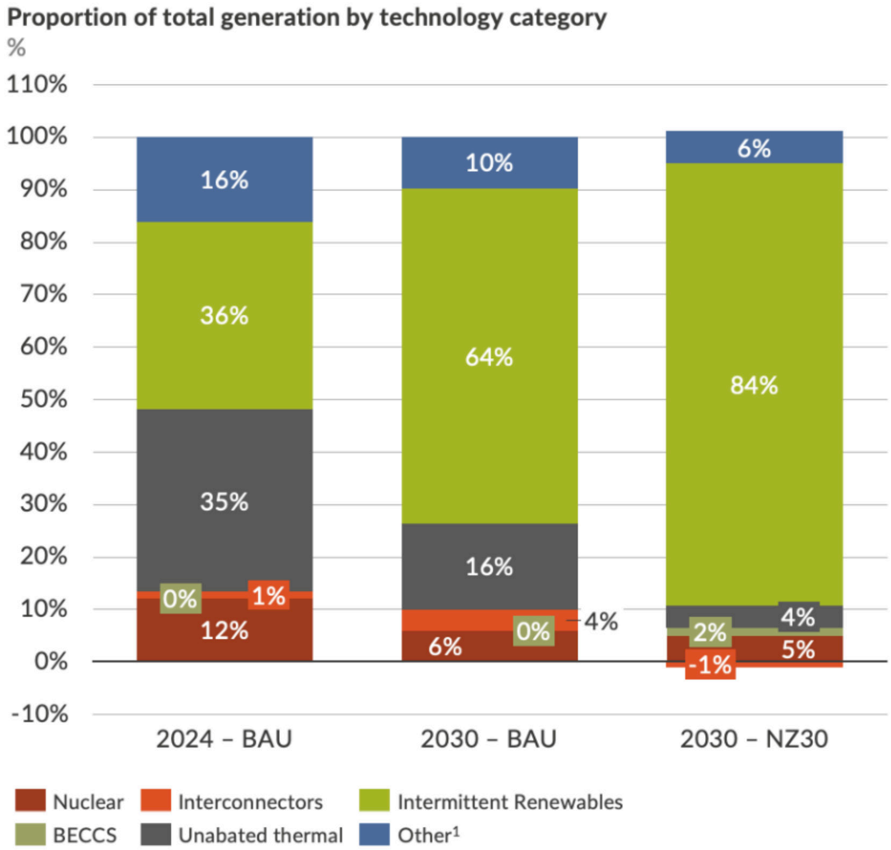


Energy Mix: Intermittent renewables make up 84% of the NZ 2030 energy mix. To accelerate the phasing out of gas the carbon price is increased to 54% above BAU in 2030, however there remains 4% unabated thermal[43] (16 TWh) in the energy system. This is to ensure security of energy supply and to act as an insurance policy for periods of peak demand that cannot be met by renewables, low carbon and flexible energy sources. Additionally the removal of gas-fired CHP in this scenario is unlikely as industrial processes reliant on this will be unable to adapt to new fuelling in time. By comparison, NZ 2030 unabated thermal generation requirement is four times lower than the BAU scenario in 2030, where unabated thermal makes up 16% (57 TWh) of the energy mix.

The carbon emissions generated in this scenario would be offset through negative emissions generated by BECCS, requiring 1 GW of BECCS capacity running at base load by 2030. However this technology's deployment would need to be accelerated over the next 6 years, given a report[44] commissioned by Drax forecasts only x1 biomass unit will be converted to a BECCS unit (with a benchmark capacity of 460 MW)[45] by 2030, delivering 4 $MtCO_2e$ savings per year. Additionally interconnectors read as -1% as this will be accounting for net exports of electricity.

43. Unabated thermal includes coal, gas CCGTs, CHP, biomass, gas and oil peakers.
44. Drax (2024), 'The value of BECCS at Drax Power Station'.
45. Drax (2022), 'Needs and Benefits Statement'.

Figure 8.4: Technology generation % split for BAU 2030 and NZ 2030.



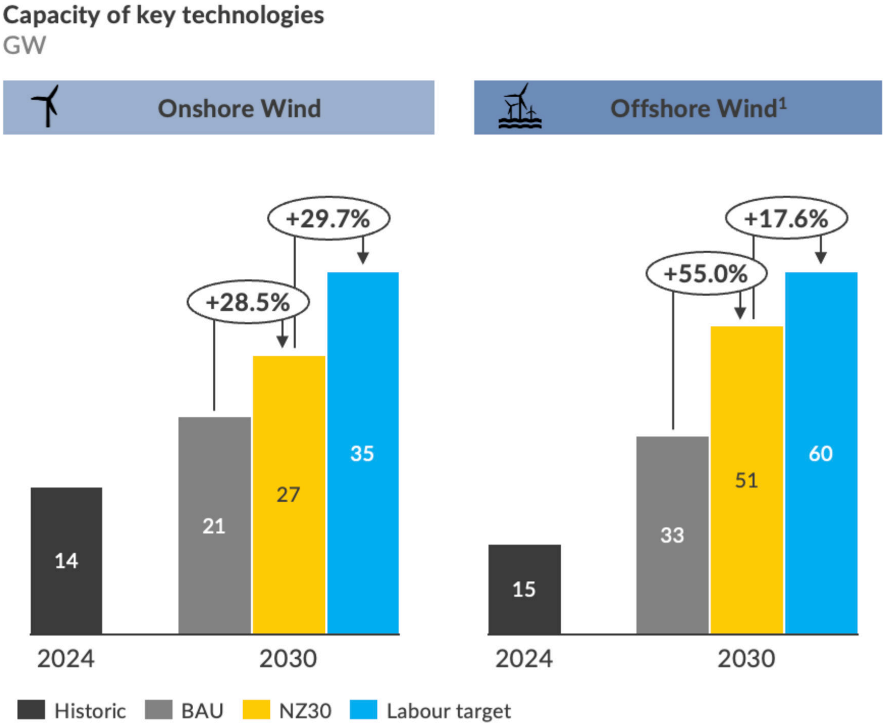
1) Includes generation from storage, demand-side response (DSR), hydrogen peaking plants, hydrogen CCGTs, BECCS, biomass and gas CCS.

Labour 2030: In contrast Labour's policy calls for 100% clean power by 2030, which would see an aggressive growth in key low-carbon generation technologies, supply chains, and related grid and planning updates. Labour's targets would necessitate an unprecedented expansion in installed capacity for these technologies by 2030.

The NZ 2030 scenario modelled by Aurora and represented here, outlines a least effort pathway to decarbonization by 2030, while ensuring a stable grid, with minimal reliance on unabated gas that would be offset through BECCS. Compared to a 100% clean power scenario, it sees a less demanding build-out requirement for solar PV, electrolysers, offshore wind and onshore wind, with Figure 8.5 highlighting the marked difference in wind capacities between Labour's 2030 and Aurora's NZ 2030 scenario.

However, despite this 2030 Net Zero scenario being more realistic than a 100% clean power grid, Aurora still deems NZ 2030 as an infeasible scenario, due to the legislative timeline, planning, permitting and project development and supply chain limitations, preventing the necessary system overhaul to be completed in this timeframe.

Figure 8.5: Offshore and onshore wind capacity differences between Labour 2030 and Aurora's NZ 2030 scenario.



1) Includes floating offshore wind.

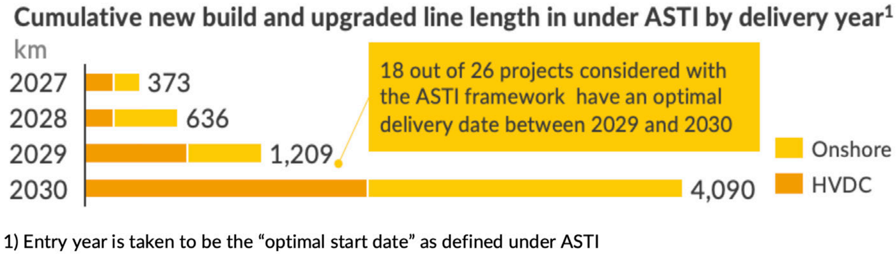
Constraints Preventing 2030 Delivery

The constraints to enable a Net Zero power system outlined below apply to both the Net Zero scenarios, however they will be felt to a much greater extend within the NZ 2030 scenario, given the timescale to reach Net Zero is halved.

Supply Chains and Skills: Global supply chains have been significantly impacted by the current state of geopolitical tension, given Russia's invasion of Ukraine, war in the Middle East and attacks by Houthi rebels on maritime shipping routes in the Red Sea. The impacts of constrained supply chains will place exceptional stress on meeting Net Zero targets and significantly more so on earlier targets. This impact is compounded by the increasing competition for scarce skill sets in developing sectors, such as skilled workers within the CCS industry, which requires rapid expansion from its underdeveloped state.

The Accelerated Strategic Transmission Investment (ASTI) framework will see key transmission upgrades and new lines deployed by 2030, to support the current 50 GW offshore wind target, with offshore High Voltage Direct Current (HVDC) links from Scotland to England. Under ASTI's framework, Aurora estimates 4090 km of new build and upgraded lines will be required by 2030, for both onshore and HVDC cables.

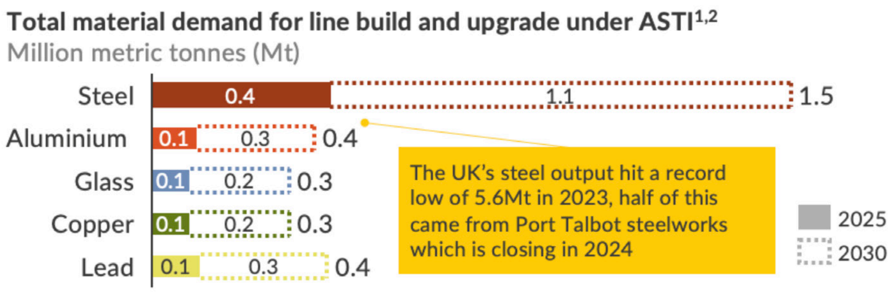
Figure 8.6: Cumulative new build and upgraded line lengths under ASTI by delivery year.



1) Entry year is taken to be the "optimal start date" as defined under ASTI

However to achieve the upgrades under the ASTI framework will require supply chains for key raw materials to scale up from between 250-400%. Most significantly, 1.5 million metric tonnes (Mt) of steel will be required to enable the transmission line build and upgrade under ASTI. In comparison, by 2025 the total steel demand for line build and upgrade will sit at 0.4 Mt. This significant increase will be hampered by the closing of Port Talbot steelworks in 2024. By further accelerating grid build requirements, relative to ASTI, under the NZ30 scenario presented, total material demand is expected to proliferate significantly beyond that of ASTI's requirements illustrated in Figure 8.7.

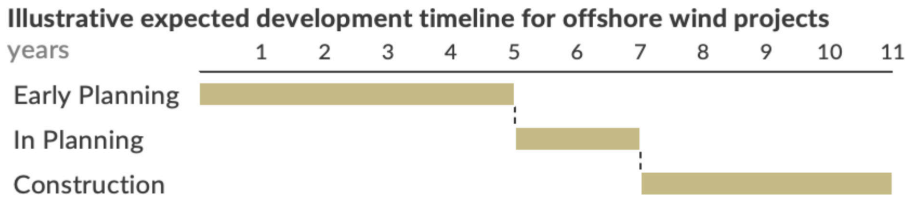
Figure 8.7: Material demand required for network line build and upgrade, under ASTI



1) Considers material demand for line build; 2) Assumes an average cable weight of 0.067t/km-MVA for underground cables and 0.023t/km-MVA for overground cables.

Planning and Consent: Infrastructure investments within the energy sector are suffering due to constraints surrounding planning and consenting. Uncertainty around market design, grid connection queues and a competitive global landscape with competing subsidy schemes, e.g. EU's Clean Energy Package, may hinder GB's ability to attract investment for renewable capacity. Figure 8.8 illustrates the expected delivery timeline for offshore wind projects, with over half the time taken up in 'early planning' and 'in planning'. An unfavourable planning timeframe such as this, will present an insurmountable challenge to the renewables build out required under a NZ 2030 scenario.

Figure 8.8: Expected development timeline for offshore wind projects.



Financing: Technologies that have a high capital expenditure, such as nuclear and pumped hydro storage, will require bespoke risk mitigation financing, which in turn may cause issues in raising debt and equity, due to the high risk nature of the projects. Attracting capital for renewable projects will become more difficult with increased competition, while the acceleration of renewable technologies will likely lead to a suppression in capture prices and a higher dependency on subsidy spending.

Generation Financial Implications

New Build Renewables: On average, from 2025 to 2030, it will require £15.6 bn/year worth of investment to meet the capex costs of new-build renewables if the Net Zero power target is to be reached. This is on top of already procured future capacity. [46] However, it is better to relate this annual cost over the 2025-2035 period (sitting at £10.6 bn/year), as it enables a direct comparison to the NZ 2035 scenario. The total cost for new build renewables over the 2025-2035 period is £116 bn.

Based on final 2023 installation levels, the following increases in renewables would be required, accounting for both newbuild and already procured capacity:

From 2025-2030

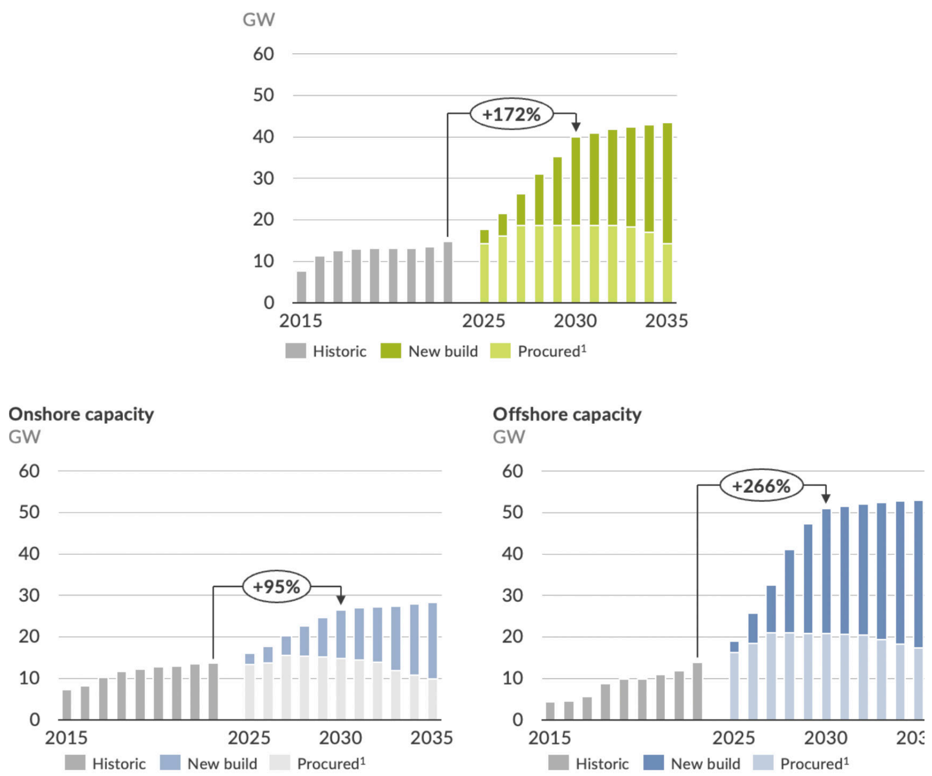
- **Solar** capacity to increase 172%.
- **Onshore wind** capacity to increase 95%.
- **Offshore wind** capacity to increase 266%.

From 2025-2035 renewable annual new build costs:

- **Solar** = £1.3 bn/year.
- **Onshore wind** = £1.9 bn/year.
- **Offshore wind** = £7.4 bn/year.

46. Accounts for capacity procured in Renewable Obligation Certificates, Feed in Tariffs and Contract for Differences up to AR5.

Figure 8.9: Renewable capacity increase required to reach NZ 2030.



1) Procured in ROCs, FiT and CfD up to AR5.

9. Net Zero 2035 Scenario

KEY POINTS

Aurora's modelling identifies that Net Zero 2035 scenario is potentially possible, but will require immediate legislative reform, with policy action, market design and financial support enacted at a large-scale and high speed.

If it were to be achieved, it would have the following impact:

CO_2 emissions:

- Net negative emissions reached in 2035 at -0.7 Mt CO_2e.
- Total carbon emissions are 137 MtCO_2e over the period 2024-2050.
- This scenario saves 285 MtCO_2e more in carbon emission compared to BAU.

Capacity Build Required:

- Renewable capacity needs to reach 117 GW by 2035, which is an additional 25 GW on the BAU scenario in 2035.
- NZ 2035 sees the following increase in **renewables** from 2024 – 2035:
    - 36 GW offshore Wind.
    - 12.4 GW of onshore Wind.
    - 26 GW of solar.
- Grid capacity across the B6 and B8 boundaries needs to reach 46 GW by 2035, an additional 7 GW on the BAU scenario in 2035.

Renewable New Build Costs Over the 2025-2035 Period:

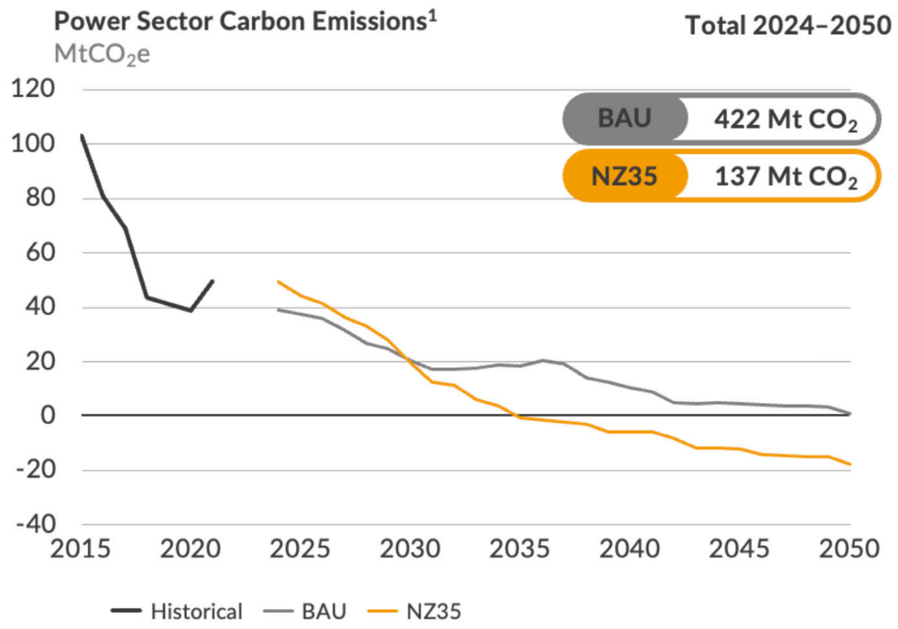
- £8.2 bn/year of additional investment until 2030 (a total of £49.3 bn).
- £11.1 bn/year of additional investment from 2031 – 2035 (a total of £55.3 bn).
- Total additional investment of £104.6 bn over next 11 years.

Overview

Reaching the Government's current target of a Net Zero power system by 2035, though more feasible than a NZ 2030 scenario, will still however require an extensive systems level change and significant policy intervention. In this scenario there are a number of deviations away from the BAU scenario, alongside the increased demand (29% for BAU and 43% for NZ 2030/5) there is a rapid increase in renewables buildout required, reaching 117 GW by 2035, an uplift of 25 GW compared to BAU. Here we see renewables, nuclear and imports accounting for 82% of total generation with 6% of unabated thermal offset by BECCS. A higher carbon pricing has been applied to facilitate the reduction in unabated gas, but has been kept in the energy mix for energy security purposes.

A sharp reduction in short term carbon emissions will need to be achieved over the next 11 years, as carbon emissions in this scenario reach -0.7 $MtCO_2$ by 2035. For period 2024-2035, 137 $MtCO_2e$ will be produced, saving 285 $MtCO_2e$ more than the BAU scenario.

Figure 9.1: NZ 2035 and BAU scenario power sector carbon emissions.

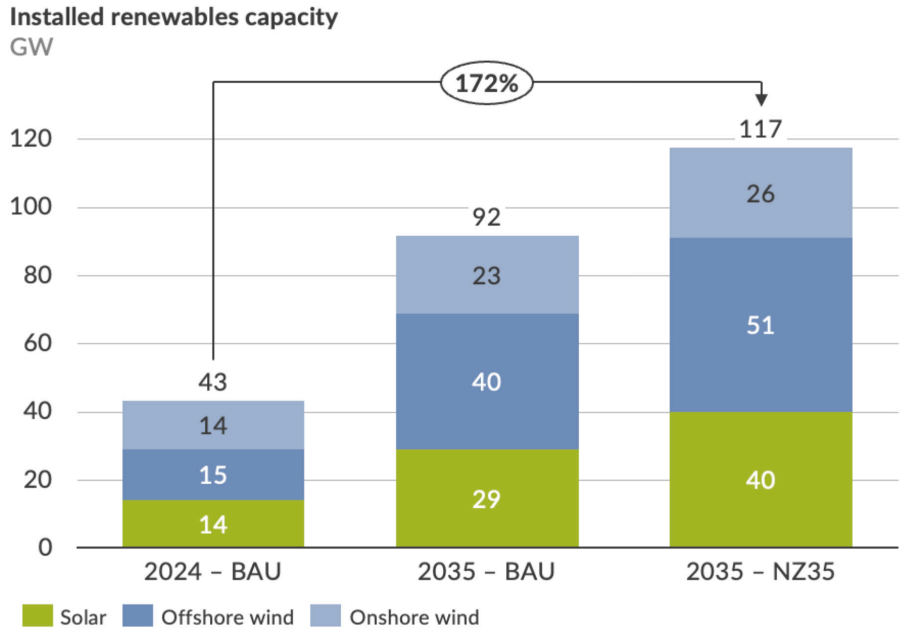


1) Includes negative emissions from BECCS assuming a factor of -941 gCO2 /kWh.

Additional Capacity Build Required

Renewables: Capacity across renewables increases to 40 GW for solar, 26.4 GW for onshore wind and 51 GW for offshore wind by 2035, totalling a 117 GW of renewables. This is a 172% increase on 2024 levels and a 27% increase on the BAU scenario in 2035. This increase in capacity is significantly greater than the historic build rates for GB, to which the current planning schemes and market setup are ill-equipped to support and will require a high degree of reform. It would require offshore wind deployment to increase from a historic 1 GW/year to 3.2 GW/year, and solar to increase from a historic 1.2 GW/year to 2.3 GW/year, however this is half the pace of deployment required for the NZ 2030 scenario.

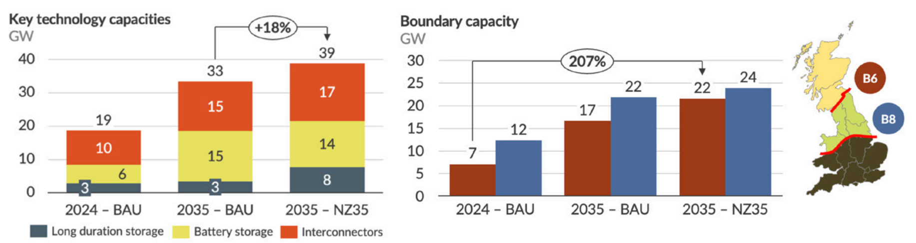
Figure 9.2: Renewable energy generation capacity increase required for NZ 2035.



Flexibility and Grid: As per the BAU and Net Zero 2030 scenario there is a need to increase flexible generation and grid capacity that are essential to support the build out of renewable energy systems. Flexible technologies in this scenario would see battery storage increase to 14 GW, LDES to 8 GW and interconnectors reach 17 GW by 2035, overall doubling total capacity on 2024 levels and an 18% increase on the BAU in 2035. Within the Aurora model it is assumed that the current pipeline of assets could reach this capacity, however there are significant issues around grid connections, long timelines for large projects and lack of firm support for long duration energy storage.

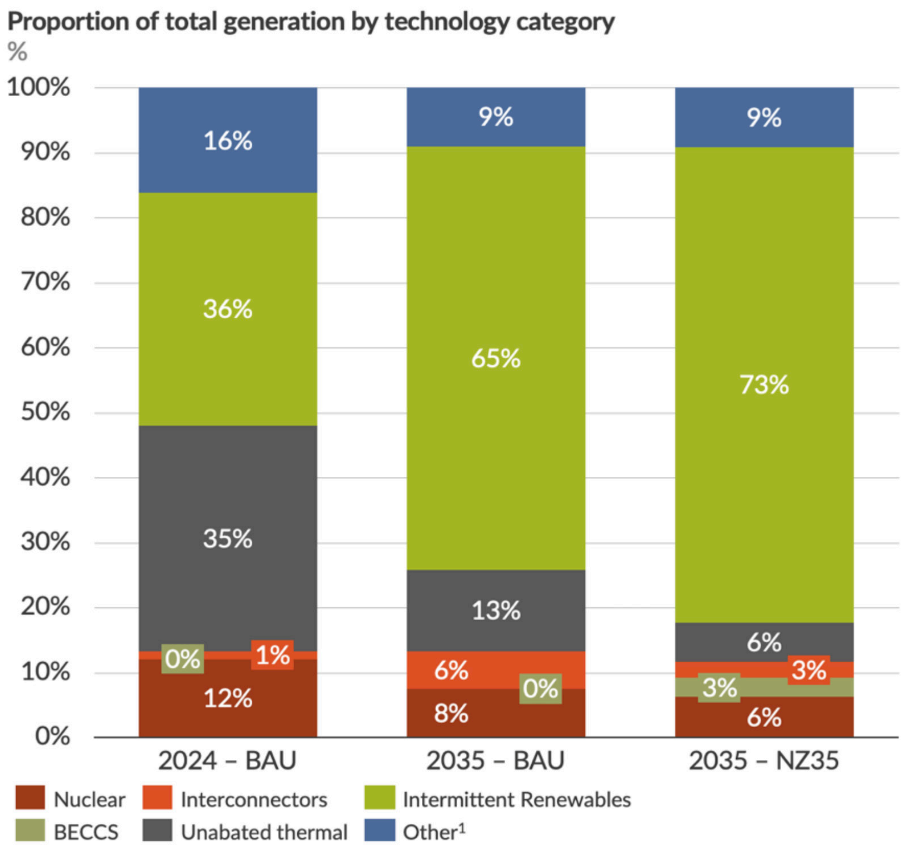
The grid's transmission and distribution system increases by the same capacity as the NZ 2030 scenario, however simply 5 years later, with B6 increasing to 22 GW (x3 2024 levels) and B8 to 24 GW (x2 2024 levels), with an overall 18% increase on the BAU 2035 scenario. This is a significant increase compared to historic build out rates of the grid, however more feasible than NZ 2030 scenario, given there is twice the length of time to achieve it and would require half the build rate.

Figure 9.3: Flexible technology and grid capacity build out rates under BAU 2035 and NZ 2035.



Energy Mix: Intermittent renewable generation makes up 73% of the energy mix in NZ 2035, an 8% increase on BAU in 2035. Net Zero is reached in this scenario, however unabated thermal[47] generation (6% of total generation, 27 TWh) is still required to ensure system security and meet peak demand when other technologies cannot fulfil demand requirements. Comparatively BAU in 2035 holds 13% (50 TWh) unabated thermal in its energy mix. The carbon price in NZ 2035 is set 27% higher than BAU in 2035 to accelerate the phasing out of gas, however using this as a policy lever will likely result in higher peak prices when gas peaking plants are utilised to meet demand.

Figure 9.4: Technology generation % split for BAU 2030 and NZ 2035.



1) Includes generation from storage, demand-side response (DSR), hydrogen peaking plants, hydrogen CCGTs, BECCS, biomass and gas CCS.

The emissions generated are offset through negative BECCS emissions, with BECCS capacity sitting at 3.3 GW in NZ 2035. Although it is unlikely that BECCS will be able to be deployed at this scale by 2035 given the pace of development, where Drax are seen to be the sole deployers of this technology. A report[48] commissioned by Drax estimates the company will reach x2 BECCS units (each with a benchmark capacity of 460MW)[49] by 2035, saving 8 $MtCO_2e$ per year from 2035. Additionally interconnectors proportion of the energy mix sits at 3% lower than BAU in 2035, as greater inflexible renewable capacity is brought online

47. Unabated thermal includes coal, gas CGGTs, CHP, biomass, gas and oil peakers.
48. Drax (2024), 'The value of BECCS at Drax Power Station'.
49. Drax (2022), 'Needs and Benefits Statement'.

Generation Financial Implications

New Build Renewables: On average, from 2025 to 2035, will require £9.5 bn/year worth of investment to meet the capex costs of new-build renewables if NZ 2035 is to be achieved, on top of already procured[50] future capacity. The total cost for new build renewables over this period is £104.6 bn.

Based on final 2023 installation levels, the increase in renewable capacity required from 2025-2035 can be seen below, accounting for both newbuild and already procured capacity. The % increases are similar to NZ 2030, however the annual investment required is less given the additional 5 years to reach a Net Zero scenario.

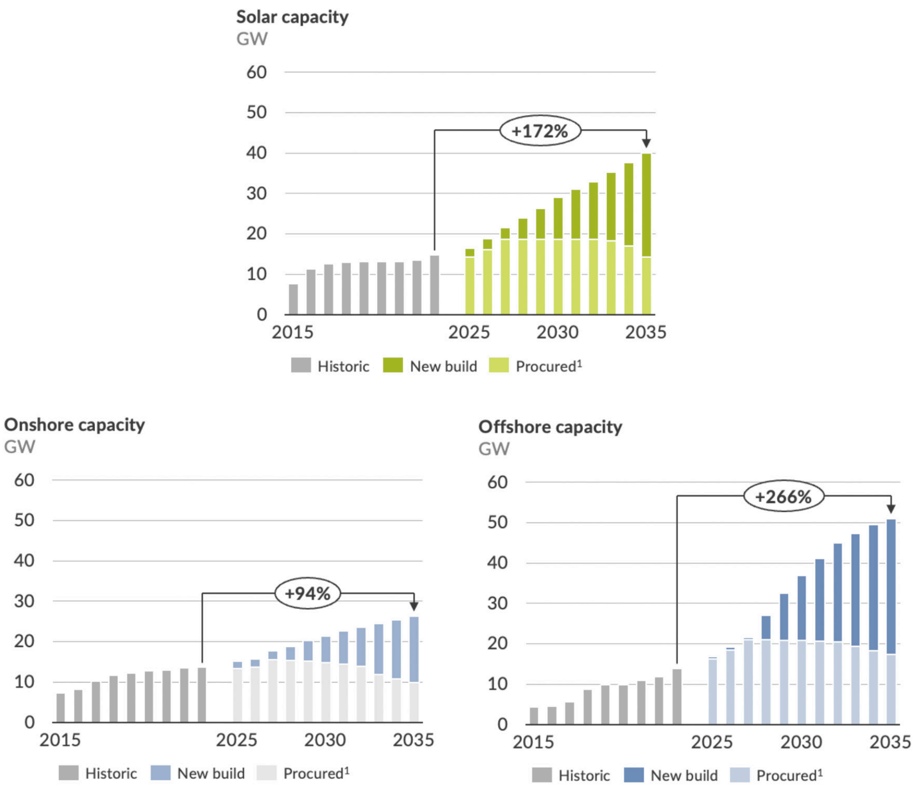
From 2025-2035

- **Solar** capacity to increase 172%.
- **Onshore wind** capacity to increase 94%.
- **Offshore wind** capacity to increase 266%.

From 2025-2035 renewable annual new build costs:

- **Solar** = £1.1 bn/year.
- **Onshore wind** = £1.7 bn/year.
- **Offshore wind** = £6.8 bn/year.

Figure 9.5: Renewable capacity increase required to reach NZ 2035.



50. Accounts for capacity procured in Renewable Obligation Certificates, Feed in Tariffs and Contract for Differences up to AR5.

10. Conclusion

The UK's requirement to achieve a decarbonised power system fundamentally underpins our ability to reach Net Zero by 2050. It acts as a lynch pin to decarbonise other sectors in the wider energy transition, such as heat and transport, shifting them away from being reliant on fossil fuels and powered by renewable and low carbon generated electricity.

It is encouraging that both Labour and Conservative have made decarbonisation of the power sector an agenda priority, however their significantly different respective targets of 2030 and 2035 require scrutiny to understand both the costs and the benefits, and whether they are optimal targets for the energy system.

Aurora Energy Research's rigorous analysis for Policy Exchange into the three different scenarios of reaching a Net Zero power sector by; **Business and Usual[51] (BAU)**, a **Net Zero 2030 scenario** and a **Net Zero 2035 scenario**, has provided clarity to the challenge ahead and will help inform the political debate.

51. BAU: A scenario following the current trajectory of policy development and market environment for the GB power sector generally aligned with Aurora's regularly published Central scenario.

11. Appendix: Key Statistics

	2024	BAU 2030	Net Zero 2030	BAU 2035	Net Zero 2035
Renewable and Low Carbon Capacities (GW)					
Offshore Wind	15	33	51	40	51
Onshore Wind	14	21	27	23	26
Solar	14	24	40	29	40
Interconnectors	10	15	15	17.3	17.3
Battery Storage	6	14	20	15	14
Long Duration Energy Storage	3	3	9	3	8
Nuclear	6	2.8	2.8	4.5	4.5
BECCS	0	1	1	3.3	3.3
Installed Grid Capacity (GW)					
Total Installed	19	26	46	39	46
Boundary 6	7	12	22	17	22
Boundary 8	12	14	24	22	24

	Historic[52]	NZ 2030	NZ 2035
Build Rates: Yearly Average Increase in Capacity (GW)			
Offshore Wind	1	6	3.2
Onshore Wind	0.9	2.1	1.2
Solar	1.2	4.3	2.3
Battery Storage	0.3	2.5	0.7
Long Duration Energy Storage	-	1	0.4
Gas CCS	-	0.7	0.6
BECCS	-	0.2	0.3
	BAU	**Net Zero 2030**	**Net Zero 2035**
Annual Power Demand (TWh)			
2024	307	316	316
2035	396	453	453
2050	499	655	655
CO_2 Emissions (Mt CO_2)			
Total Emissions 2024-2025	422	- 192	137
Renewable New Build Costs for 2025-2035 period (£/Year)[53]			
Total	-	10.6	9.5
Offshore Wind	-	7.4	6.8
Onshore Wind	-	1.9	1.7
Solar	-	1.3	1.1

52. Historic rates for wind and solar are from 2013-2023, battery storage is form 2018-2023.
53. From 2025-2030 for NZ 2030 scenario and 2025-2035 for the NZ 2035 scenario.

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